

**"Interoperability at the Speed of Sound: Canada-United States Aerospace
Cooperation.....Modernizing the CF-18 *Hornet*"**

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Maxwell AFB, Al 36112

Defence budgets across the world are in a downward spiral from the need to cash in on the "peace dividend." The United States and Canadian air forces are feeling the negative effects of reductions and new approaches are being taken by policymakers and military planners to meet the increased demands on the remaining defence establishment. Interoperability is the latest "buzz" word in the military community; nations must deploy forces more efficiently and in closer concert with other instruments of power. The Secretary-General of NATO, Lord George Robertson of Port Allen speaking to the 45th Annual Session of the NATO Parliamentary Assembly in Amsterdam on 16 November 1999 said, "Collectively, the European members of NATO spend almost two-thirds of the US defence budget, but Kosovo made it clear that they have nothing like two-thirds of the real capability of the United States."¹ Lord Robertson went on to say, "the European Allies must look critically at the balance of their armed forces and look at how they can operate together more effectively."²

The US has placed greater emphasis on its NATO allies to increase funding for purchases of new equipment and the modernization of old equipment, all with the aim of ensuring standardisation, rationalisation and interoperability of assets. Interoperability between the USAF and the Canadian air force is a success story, but the road has not been easy and without cost. What were the significant lessons learned and improved upon from the deployment of Canadian CF-18 *Hornets* in Operation DESERT STORM (the Persian Gulf War)? From 1991-1999, how did Canada renew its' focus on doctrine, training in annual exercises between the two nations, such as Maple Flag, Red Flag, William Tell, NORAD exercises, and funding of vital capital equipment modifications of the CF-18? Did the Canadian 1994 Defence White Paper stress the need for Canadian air force to maintain military interoperability and technological interface with US systems to ensure Canada-US Security relations? What was Canada's involvement in

Kosovo air operations with CF-18s in Operation ALLIED FORCE (Canadian air operations were named Operation ECHO)? Did the deployed CF-18s operate interchangeably with United States air assets (including USAF, USN, USMC) in a major air campaign? Were the CF-18s able to conduct the full spectrum of air operations? Based on the lessons learned in Operations DESERT STORM and ALLIED FORCE, what requirements exist for a CF-18 Incremental Modernization Program? What are the associated costs? What is the impact on Canada-US security cooperation, treaty obligations and commitments if modernization is not enacted?

This paper first provides a baseline of the term "interoperability" then examines the complexities of interoperability issues in the fighter community. It will not discuss required interoperability technical architecture frameworks for information management across all fields, for example C4I (command, control, communication, computer and intelligence) networks, systems, or standards required to execute military operations, Air Force Technical Reference Codes, or Battlefield Management with the Airborne Battlefield Command and Control Centre (ABCCC) or Airborne Warning and Control System (AWACS) being fitted with Joint Tactical Information Distribution System (JTIDS). This article only focuses on the simplistic requirements of operating CF-18s in conjunction with United States air assets. It then provides a historical account of the vital lessons learned from Operation DESERT STORM in 1991 (Canadian naval and air operations were code named Operation FRICTION) and how modifications made within the Canadian air force from 1991 through 1999 affected Canadian participation during Kosovo air operations in Operation ALLIED FORCE in 1999. Finally, it looks at Canada's ambitious planning efforts currently underway with an Omnibus CF-18 Incremental Modernization Project (in a 2-phased approach through 2008) and the possible implications for Canadian national security if not enacted

Interoperability -- a common reference point

Modern warfare is clearly changing, yet there are some things that do not change. Throughout history, soldiers, sailors, Marines and airmen have learned one extremely valuable lesson relative to engagement with an opposing force. That is, if you can analyse, act and assess faster than your opponent -- you will win.³ American and Canadian policymakers are dedicated to designing, developing and implementing a lean, team-oriented air force capable of defending the North American continent and our NATO allies in the face of unprecedented technological change, dynamic world-wide politics and internal reductions in budget and manpower.

The mandate of the USAF is to "fly, fight and win" the nation's wars when called upon to do so. Winning the nation's wars requires a very thorough understanding of the complexities of modern warfare. One of the constants of warfare in the 20th century has been the need to gain control of the air over both friendly and enemy territory. Simply put, air superiority has become critical in winning wars with the fewest losses. In light of the disdain from the public on the issue of casualties, gaining air superiority has become a strategic imperative for the US and its allies. During the Persian Gulf War, the coalition's total air and space superiority over Iraq provided the coalition with tremendous leverage and opportunity. Iraqi forces could not function and operate in the face of such air superiority and freedom of action.

More than 50 years ago in North Africa, Field Marshal Erwin Rommel summed up the problem. Field Marshal Rommel had done extremely well in the North African campaign, until he lost air superiority. After that he wrote, "Anyone who has to fight, even with the most modern weapons, against an enemy in complete command of the air, fights like a savage against modern troops, under the same handicaps and with the same chances of success."⁴ In the future, maintaining control of the air will even be more difficult, as was demonstrated during Operations

DESERT STORM and ALLIED FORCE. Although among the most capable that the US has faced in combat, the Serbian air defence systems did not represent the state of the art.⁵ Much more capable systems are currently available for sale in the international market. In the years ahead, coalition and allied air component commanders can expect to face adversaries armed with the state-of-the-art systems that will be difficult to detect and kill. Future hostile environments will most likely include manned and unmanned, stealthy and non-stealthy vehicles, ballistic missiles and cruise missiles. Manned aircraft will continue to pose a danger, especially if carrying cruise missiles. Several of today's advanced foreign fighters are approaching parity with US fighters in terms of performance and lethality. Aircraft like the French *Rafale* with Apache cruise missile, the *Eurofighter 2000* and the Russian Su-35 *Super Flanker* and the S-37 *Berkut* have exceptional manoeuvring performance⁶; these aircraft are proliferating across the world, along with AMRAAM (advanced medium-range air-to-air missile) type missiles. In addition, relatively cheap and very effective SAM (surface-to-air missile) systems must be dealt with, including SA-3's and SA-6's as demonstrated in Kosovo. The enemy must not have sanctuaries from which they can attack with impunity. Today, more than 15 different countries possess operational SAM missiles and more are attempting to acquire them.⁷ SAM's are also growing more sophisticated with improved accuracy and submunition warheads, to include the latest generations of SA-10's and SA-12's.

The USAF has experienced a four-fold increase in contingency operations since the end of the Cold War. We've seen the end of a comfortable bipolar, head-to-head confrontation that, by and large, involved static operations conducted in garrison.⁸ At the same time, the US and Canada have significantly reduced their active-duty military forces. In the US, the force structure went from 2.1 million men and women to 1.4 million; Canada had similar affects, with

the number going from 88,000 to 60,000 in 1999.⁹ With declining defence budgets, the Canadian air force simply can't operate any other way but jointly and with Coalition and allied partners. Today, we are seeing a much greater need for improved interoperability and cooperation. No service can expect to be entirely self-sufficient. Each service must leverage unique strengths and expertise in synergistic operations. Also required is the leveraging of jointness across coalition lines and with allies around the world. The key is a seamless, global, interoperable aerospace environment.

Interoperability....the term seems simplistic enough yet numerous definitions abound on an extremely complex topic. In 1999, the USAF produced over 81 directives, instructions, pamphlets, and planning documents on interoperability. Interoperability means different things for different weapon systems. Some systems, such as communications, may only be required to interface with a common data link, such as Link 16, while others will have a broader and more complex set of requirements. This paper will use the definition for interoperability provided in NATO Publication AAP-6. NATO Publication AAP-6 and US Joint Publication 1-02 describe four levels of standardisation within the International Military Standardisation Program:¹⁰

Compatibility – Compatibility of two or more items or components of equipment or material to exist or function in the same system or environment without mutual interference.

Interoperability – The ability of systems, units or forces to provide services to and accept services from other systems, units, or forces and to use the services so exchanged to enable them to operate effectively together.

Interchangeability – A condition which exists when two or more items possess such functional and physical characteristics as to be equivalent in performance and durability, and are capable of being exchanged one for the other without alteration of the items themselves, or of adjoining items, except for adjustment, and without selection for fit and performance.

Commonality – A state achieved when groups of individuals, organisations or nations use common doctrine, procedures, or equipment.

The goal of standardisation for the USAF is not an end in itself, but is a means to increase operational effectiveness among coalition and allied military air forces to economise resources

and enhance military capabilities.¹¹ The official policy of the USAF is to seek the highest possible and practical levels of standardisation with its allies in all areas.

In light of the numerous interoperability lessons learned from Operation DESERT STORM, the Deputy Under Secretary of the Air Force (International Affairs) implemented Air Force Policy Directive, (AFPD) 16-1, International Affairs to establish policies for the pursuit of US national security goals and objectives, improve coalition warfighting capabilities, and promote Allied air force modernization.¹² In AFPD 16-1, the USAF is tasked to conduct international activities to further the coalition warfighting capability of US partners in a manner that supports and enhances collective security and regional stability. Allied air force modernization is encouraged to foster commonality, compatibility and interoperability between US forces and allies within legal, fiscal and political boundaries.¹³

But, all of these actions only appear to be internal within the US military service departments. How does it relate to coalition and allied forces? What mechanisms exist in moving coalition and allied partners -- in particular the US and Canada -- towards effective interoperability of fighter aircraft assets?

Air operations conducted during Operation ALLIED FORCE pushed interoperability to the forefront of NATO concerns. In April 1999, members of Heads of State and Government participating in the meeting of the North Atlantic Council in Washington D.C. pledged to improve defence capabilities to fulfil the full range of the Alliance's 21st century missions. During this summit, the North Atlantic Council launched a Defence Capabilities Initiative to improve the defence capabilities of the Alliance to ensure the effectiveness of future multinational operations across the full spectrum of Alliance missions in the present and foreseeable security environment with a special focus on improving interoperability among

Alliance forces. In addition, members endorsed the North Atlantic Council's decision to develop the C3 system architecture by 2002 to form a basis for an integrated Alliance core capability allowing interoperability with national systems. Lastly, as part of the Defence Capabilities Initiative, a temporary High-Level Steering Group was established to oversee the implementation of the Defence Capabilities Initiative and to meet the requirement of coordination and harmonisation among relevant planning disciplines, with the aim of achieving lasting effects on improvements in capabilities and interoperability.¹⁴ Members of the Summit made it clear that future developments will make new demands on the capabilities required of Alliance forces, in particular in the field of interoperability. All nations must make a fair contribution to the full spectrum of Alliance missions regardless of differences in national defence structures.¹⁵

As a result of this Summit, the United States Department of Defence embarked on its most aggressive attempt to ensure US military forces can operate together and with military allies. On 1 October 1999 a new department was created in the Pentagon, that of DoD Director of Interoperability. This new office serves as the single focal point to coordinate all interoperability activities. According to Mr. Vitali Garber, the DoD's Director of Interoperability, "weapons will be judged by their ability to 'plug and fight.'¹⁶ He further stated that "interoperability will be considered as a key performance parameter in the development of individual weapons systems and military equipment; the goal is to achieve commonality with the equipment of the military services or allied capabilities."¹⁷

Clearly, as the US and Canada continues to reduce force structure, gone are the days when weapon systems were developed and fielded in stovepipes...and not work together. Interoperability and connectivity are absolutely crucial in the modern battlefield.¹⁸

CF-18 *Hornet* - - Canada's front line air defence

The twin engine, supersonic McDonnell Douglas CF-18 *Hornet* is the multi-role tactical fighter that constitutes the primary combat capability of the Canadian air force and Canada's only means of exercising active control over unwanted activities in domestic and international airspace.¹⁹ Canada began acquisition of the CF-18A/B model aircraft in 1982, with completion of the one-time procurement of 138 aircraft (of which 122 remain) by 1988. As a multi-role aircraft, the CF-18 can be configured quickly to perform either fighter or attack roles or both, through selected use of external equipment to accomplish specific missions.²⁰ The fighter missions are primarily fighter escort and fleet air defence while the attack missions are force projection, close air and interdiction. The CF-18 is ideally suited for Canadian commitments and obligations within NORAD and NATO.

The CF-18s are bedded at two locations: the 3 Wing Bagotville, Quebec and 4 Wing Cold Lake, Alberta. The general operational breakdown on an annual basis has 60 operational CF-18 fighter aircraft (in four squadrons) with 28 CF-18s in training and testing and 34 CF-18s in long-term maintenance or storage.²¹

4 Wing Cold Lake (located 290 km northeast of Edmonton) is the largest of Canada's two fighter bases with 68 CF-18s. The Wing's mission is to train, deploy and support tactical fighter forces to meet Canada's requirements at home and abroad and is primarily committed to the surveillance and defence of North American airspace under the umbrella of the NORAD agreement and as the Vanguard Wing for NATO contingency operations.²² One of the most recognised missions of 4 Wing Cold Lake is the annual hosting, over a six week period in the months of May and June, of Exercise Maple Flag, a NATO air combat exercise.²³ The aim of Maple Flag is to provide aircrew realistic training in a modern simulated environment in a

relatively unrestricted aerospace at the Cold Lake Air Weapons Range. Maple Flag is a critical component of doctrinal and tactical airspace interoperability between the US and Canadian air forces.

3 Wing Bagotville (located 200 kms north of Quebec City) provides a multi-role deployable fighter force capable of meeting international contingency missions and is committed to NORAD through air sovereignty alert duties. In addition, 3 Wing provides one Rapid Reinforcement fighter squadron to NATO.²⁴

Ageing aircraft is an issue for the Canadian air force and modernization of the CF-18A/B *Hornet* is among the Department's top priorities.²⁵ Initial CF-18A/B capabilities included: air-to-air missile capabilities with AIM-9M Sidewinders and AIM-7 Sparrows and conventional "dumb" or "iron" unguided bombs.²⁶ The CF-18A/B model aircraft were not configured with infra-red sensors and laser designators for precision-guided weapons; thus, pilots were unable to see targets at night or utilise precision guided missiles on strike missions. These two limitations reduced interoperability with US assets of equitable airframes utilised by the USN, USMC and USAF (as discussed later in lessons learned in Operation DESERT STORM). Under an aggressive 2-phased incremental modernization project, the air force is taking steps to extend the life cycle of its multi-role CF-18s, the first delivered over 17 years ago. The intent of the proposed incremental modernization program is to provide aircraft with increased interoperability, survivability, supportability and capability into the foreseeable future.²⁷ Canada's CF-18A/B fleet is now encountering parts obsolescence and supportability issues; the McDonnell Douglas F-18C/D blocks (second generation) came off the production line in 1987 and currently has the F-18E/F model (third generation) on the production line for the USN. Clearly, the operational capability of the A/B model has markedly degraded over the years

directly due to the age of the fleet; some suppliers no longer support systems of the CF-18A/B model. It has also become increasingly more difficult to support some systems as the number of spare parts diminishes and becomes impossible to support further down the road unless something is done in the near future to modernise the fleet at least to F-18C/D specifications. In its 1997-98 estimates, the Canadian government admitted that "the air forces face a serious risk of obsolescence and capability degradation in a number of key areas."²⁸ For example, in August 1999, following an incident earlier in the year when a CF-18 lost part of its vertical rudder during a training mission in Cold Lake, Alberta, the air force carried out a system wide inspection of its fleet of CF-18s to determine if problems existed with flight control surfaces. The inspection of the rudder revealed corrosion in its aluminium honeycomb structure.²⁹

The USN and USMC inventory of the McDonnell Douglas F/A-18 are C and D models as a result of a block upgrade in 1987 incorporating provisions for employing updated missiles and jamming devices against enemy ordnance. The F/A-18C/D has a tremendous external payload for air-to-air and air-to-ground missions, to include: AIM-9M Sidewinder, AIM-7 Sparrow, AIM-120 AMRAAM, Harpoon, HARM, Shrike, SLAM, SLAM-ER, Walleye, AGM-65 Maverick, JSOW, JDAM, and various general purpose bombs, mines and rockets. C and D model aircraft delivered to the USN and USMC after 1989 included improved night attack capabilities. The new components included a pod-mounted Hughes AN/AAR-50 thermal imaging navigation set, a Loral AN/AAS-38 Nite Hawk forward looking infrared (FLIR) targeting pod, a raster heads-up display, GEC Cat's Eyes pilots night vision goggles, special cockpit lighting compatible with the night vision devices, a digital colour moving map and an independent multipurpose colour display.³⁰

Throughout the F-18's service, annual upgrades to F/A-18 weapon systems, sensors, etc. continued. The latest F/A-18C/D has grown to be far more capable (night attack, precision strike, low observable technologies, etc.) than the original F/A-18A/B. Over the years, Canada has not purchased annual upgrade configurations to its first generation CF-18A/B fleet; many of these capabilities are projects contained within the forecasted Omnibus CF-18 Incremental Modernization Project.

Operation FRICTION -- the Canadian air force in the Persian Gulf War

The conflict in the Persian Gulf began on 2 August 1990, after talks between representatives from Iraq and Kuwait did not resolve grievances over oil pricing. On that date, Saddam Hussein sent his armies to invade Kuwait. On 7 August 1990, after Saddam Hussein refused to remove his troops from Kuwait, President George Bush ordered Operation DESERT SHIELD to begin; the goal was to liberate Kuwait and force the aggressor's back to Iraq. By 10 August 1990, Canada had decided to participate in Operation DESERT SHIELD.

In a press conference on 14 September 1990, Prime Minister Brian Mulroney, flanked by Secretary of State Joe Clark and Minister of National Defence Bill McKnight announced:³¹

"The government has accepted the advice of our military staff to have Canadian ships operate within the Persian Gulf. They will be under Canadian command and control and will have responsibility for a sector across the middle of the Gulf north of the Strait of Hormuz and south of Bahrain. Our ships will be operating in the same general area as the ships of the United States, the United Kingdom and other allied navies.....As a further initiative, the government of Canada today decided to deploy a squadron of CF-18 fighter aircraft from Lahr, West Germany to the Gulf to operate under Canadian control and provide air cover for our own ships and the ships of friendly nations. With supporting elements this will engage up to 450 additional Canadian military personnel in the region."

Canada's commitment was primarily sea and air in composition; ground forces were committed only to guard Canadian air bases and provide medical support to other armies. The total commitment of forces included: one destroyer; one destroyer escort; one supply ship; 24 CF-18s; 12 transport aircraft; ground troops to protect air base in Qatar; signals squadron; 300-

person field hospital unit; Boeing 707 refueller; mine clearance and bomb disposal personnel.³² This composition of forces reflected Canadian moods of the time: a poll taken in January 1991 indicated that 53 percent of Canadians wanted their troops to play only defensive roles in the area.³³ However, by late February, Canadian support for the war had changed: 58 percent of the populace favoured war against Iraq and 38 percent opposed such a move.³⁴

Prime Minister Mulroney's announcement on 14 September 1990 concerning the commitment of CF-18s preceded the acquisition of a base of operations in the region; staff at the National Defence Headquarters and External Affairs were working diligently for a possible beddown of the aircraft in Saudi Arabia, Bahrain, the United Arab Emirates, and Qatar. Total combat aircraft in the Gulf theatre of operations had already numbered over 1,000 before the Canadian offer, and France, Italy and the Netherlands were looking to establish air contingents in the region.³⁵ The US offered airport space at Doha, Qatar provided the Canadians understood there were few facilities at the already crowded base. On 29 September 1990, the Canadian government accepted the agreement. Detaching a fighter squadron to a distant theatre for operational purposes was a first in the history of 1 Canadian Air Division.³⁶ On the morning of 8 October 1990, the first CF-18s touched down at Qatar, 23 days after the Prime Minister's announcement; the air composite outfit of 24 CF-18s was known as the 'Desert Cats' (derived from the official name the Canadian Air Task Group--Middle East and because the two squadrons participating mascots were "cats" -- 439 Squadron (Tiger) and 416 Squadron (Lynx)).³⁷

Initially, the role of the CF-18s was purely defensive, in keeping with the objectives of Operation DESERT SHIELD, protecting the ships that blocked Iraqi-controlled ports. But, as the conflict progressed, and the Canadian political agenda shifted, Canadian pilots transitioned from defensive combat air patrols (CAPs) over naval sectors in the Persian Gulf to that of sweep

and escort missions, and then, as the ground offensive of the Allied force commenced on 24 February 1991, the Canadian pilots began interdiction missions into enemy territory. Throughout Operations DESERT SHIELD and DESERT STORM the Desert Cats flew more than 5,700 hours--about 2,700 combat air patrol missions and undertook fifty six bombing sorties.³⁸ It was the first time since 1945 that Canadian aircraft were deliberately placed in harm's way, and the task was completed without losing any aircraft.³⁹

From October 1990 through February 1991, CF-18s operated in three phases of air operations; below is a brief description of each phase and the interoperability issues and lessons learned from Operation FRICTION.

Defensive Combat Air Patrols. According to the Gulf War Air Power Survey, one third of the air defence patrols were carried out by non-American forces, some 9,000 sorties in all for Operations DESERT SHIELD and DESERT STORM.⁴⁰ CF-18s accounted for nearly 2,400 of these sorties, including 1,600 before the start of hostilities.⁴¹ When one factors in the smaller number of Canadian aircraft available, the Desert Cats clearly shouldered a large share of the combat air patrol mission.

At the start of Operation DESERT SHIELD in August 1990, the territorial air defence theatre of Saudi Arabia, the Persian Gulf and the Strait of Hormuz was divided into five sectors. These grouped together many defensive patrol circuits, which were occupied at all times by Coalition aircraft. From a sector of operations in the northwest, the sectors controlled access to the entire Persian Gulf and to individual ships enforcing the blockade against Iraqi shipping. Sectors had code names Whiskey, derived from the radiophonic code for the letter "W." The first naval air defence circuits over the Gulf positions were: Whiskey-1, Whiskey-2, and Whiskey-3, placed respectively at the north, centre, and south of the Persian Gulf.⁴² The

Whiskey-2 circuit was tactically less important than Whiskey-1, because it was much farther from the borders of Iraq. The CF-18s patrolled Whiskey-2 alongside with Marines of the 3rd Marine Air Wing which operated with 48 F/A-18s from the Sheikh Isa Base in Bahrain. The CF-18s were well suited for this mission; the aircraft carried the latest versions of air-to-air missiles (AIM-7 Sparrow and AIM-9M Sidewinder). At the end of October, CF-18s took regular part in the Whiskey-1 circuit alongside with the Marine Corps F/A-18s. By the end of November, CF-18s operated on their own within Whiskey-1 circuit. From the moment the CF-18s assumed the patrols of Whiskey-1, the Marine Corps F/A-18s were freed to prepare for the first round of night bombing. Their role was to defend the Coalition fleet against counterattacks from well identified airfields in Iraq and Kuwait. CF-18s conducted this mission from October 1990 through January 1991, when Prime Minister Mulroney released the deployed CF-18s to conduct sweep and escort missions with Coalition aircraft.

Problem: Deficiencies in Tactical Air Communications (i.e. Link-4 digital data receivers). The matters of secure voice communications, that of Link-4 ship-to-aircraft computer communications, was vitally important in protection of the Coalition fleet in the Persian Gulf. In mid-October, a pilot reporting to the Minister of National Defence on the operational conditions of the Gulf, described the air situation as "congested....on average 20-35 aircraft are being tracked in the central Persian Gulf airspaces....17 commercial air are in transit at any time and at dawn some 8-10 Iraqi aircraft and as many USN/USMC/CF-18s airborne in CAP stations. The potential for blue-on-blue, or worse an innocent civilian engagement was high."⁴³ Only the progressive adoption of compatible naval air systems (specifically Link-4 computer communications) would enable CF-18s to exercise fully their functions as defenders of the Coalition fleet. Until then, when suspicious situations developed, the warships went through a

quick reaction procedure known as Resolve, whereby all available radar and electronic sensor information was rapidly collated to determine an aircraft's true identity, while other operators using military and civilian air distress frequencies alerted the suspicious aircraft; clearly this approach would not work in wartime. Another situation of concern occurred in late-December 1990. On D-16, a flight of CF-18s were vectored in pursuit of Iraqi aircraft venturing beyond the territorial limit of Kuwait. However, CF-18 communications, which were efficient but less advanced than those of US aircraft, slowed down their intervention.⁴⁴ In wartime every second would be crucial to the protection of the ships; something had to be done to improve the CF-18s position in the air. After a month of special diplomatic negotiations and military representations made in Ottawa and Washington D.C. the Link-4 computer communications system was obtained for the deployed CF-18s. The US digital data receivers were installed in January 1991 with the first CF-18 flight with the Link-4 system made on D-2. By 13 January 1991, all CF-18s were equipped and missions were conducted to allow the pilots to use the new Link-4 sets in various circumstances and to train the ground crews in degrees of operational intensity to which they were unaccustomed.⁴⁵ The newly acquired Link-4 display system, along with the digital image animated and filtered by the cruiser, provided the CF-18s with details pertinent to their sector of immediate interest.⁴⁶ These improvements significantly improved the CF-18s ability to complete the mission and ultimately created a direct link to the anti-aircraft cruiser's at sea. This allowed the CF-18s to be placed on proper alert within NAVCENT.

Sweep and Escort Missions. CF-18s began sweep and escort missions with US aircraft on 24 January 1991; this marked the first time since the Korean War that Canadian aircraft had been involved in offensive air combat.⁴⁷ During the first few days of the war, the F-16C *Falcon* Squadron at Doha, Qatar lost three aircraft in quick succession while conducting interdiction

missions into deep enemy territory. Despite the great reduction in the capabilities of the Iraqi anti-aircraft networks, additional interdiction strikes were needed to suppress the remaining point defences. On 17 January 1991, Prime Minister Mulroney provided immediate authorisation for CF-18s to conduct sweep and escort missions and the reduction of Canadian air force responsibility for Whiskey-1. The CF-18s were tasked to flush out the Iraqi air force, either by forcing Iraqi defensive fighters to take off, in which case the CF-18s would confront them, or by provoking illumination of the enemy's missile guidance radar, which electronic counter-measures aircraft would attack and neutralise as the bomber aircraft flew its mission. CF-18s continued sweep and escort missions through 24 February 1991 when the mission turned to interdiction strikes. Problems:

1) Lack of secure voice radio communications--specifically the Havequick system.

Reports from CF-18 pilots during sweep and escort missions were disquieting. Radar detectors in the CF-18 cockpits jumped from one type of SAM to another, registering serious and even lethal levels.⁴⁸ The pilots were forced to carry out evasive manoeuvres. More importantly, the chances of a blue-on-blue accident were increasing because of the sheer volume of air traffic crossing the border and the lack of adequate secure voice radio communications. Communications for the CF-18s in the Dhahran sector were very poor. Although the CF-18s were now equipped with the Link-4 system to function in the naval setting, the mission had changed on 20 January 1991 from defensive CAPs to sweep and escort missions and now the CF-18s required the use of Havequick secure voice radios. This problem was never rectified with equipment or software exchanges with US aircraft (i.e., the Link-4 situation). Rather, sweep and escort missions continued throughout February, not only with F-16 *Falcons* but also with RAF *Tornado* aircraft. The only change: low-altitude bombing missions were modified to

take place at higher altitudes, thus assuring more protection against enemy missiles and artillery.⁴⁹

2) Inadequate Strategic Refuelling Capability. At the onset of Operation DESERT SHIELD, Canada deployed a strategic refuelling aircraft, a Boeing 707 nicknamed *Husky One*, to support the CF-18 mission of naval fleet defence. But, on 30 January 1991, *Husky One* was grounded due to hydraulic problems after sixteen consecutive days of operations. This became a serious problem for the CF-18s. There were many different types of Coalition tankers in the region, but most had nozzles that were incompatible with CF-18 equipment. During Operations DESERT SHIELD and DESERT STORM the USAF deployed 256 KC-135 *Stratotankers* and 46 KC-10 *Extenders* to the Persian Gulf.⁵⁰ On D-1, KC-135s were refitted with navy-compatible probes and drogues (which the CF-18 used) to allow for refuelling of the CF-18s. On D-1, the Canadian government provided official authorisation to the CF-18s to receive fuel from USAF, RAF and USN tankers.⁵¹ The problem of an inadequate strategic refuelling capability was never rectified during Operation DESERT STORM; the Canadian air force only had tactical air refuelling capability with its C-130 *Hercules*.

Interdiction Missions. The CF-18 bombing effort was only a small part of the Coalition interdiction plan, but it freed other, better-equipped aircraft to provide deep strikes with precision-guided weapons. The Desert Cats carried out 56 bombing missions between 24-28 February 1991.⁵² On 24 February 1991, the commencement of the ground attacks by the Coalition forces, CF-18s dropped 32 Mark-82, 500-pound general purpose bombs on a concentration of artillery in southern Kuwait. During these four days, Canadian pilots were guided by USAF AWACS and ABCCC and assisted by JSTARS aircraft, which would locate

and follow the enemy's movements. From 16 January through 27 February 1991, four AWACS aircraft were continuously airborne controlling more than 3,000 Coalition sorties each day.⁵³

Problems:

1) Lack of precision-guided munition capability. CF-18s were never upgraded or reconfigured after the 1989 production of C/D model aircraft with infra-red sensors and laser designators for precision-guided weapons. American pilots dropped 7,400 tons of precision-guided munitions with deadly effectiveness in Operation DESERT STORM; the USAF was responsible for approximately 90 percent of the total PGMs dropped, to include GBU-12, -15, -24, -27 and AGM-65 Maverick missiles.⁵⁴ The role of the CF-18 was limited to strike missions only requiring that of general purpose "dumb" bombs against enemy targets; this focused their efforts mostly against artillery and vehicle convoys. As a workaround solution, the USN offered the use of 1000-pound laser-guided bombs to be dropped by CF-18s in a "buddy bomb" fashion, guided by an LANTIRN-equipped aircraft to the target.⁵⁵ Sixteen high-precision bombs for specific targets were identified but the mission was never completed before the end of the war. This problem was never rectified during Operation DESERT STORM; it became a valuable lesson learned from the war effort by the Canadian air force.

2) Tactical operations of bombing missions; training and doctrine differences. Canadian pilots were trained in Europe for low-level interdiction missions. But, in the Gulf War the Coalition was not NATO and Iraq was not Europe. The Coalition was hitting Iraqi targets with high-altitude bombing and Canadian pilots were not trained in that area. This was rectified in December 1990 with the use of "red" exercises in which one group played the enemy and pushed the pilots to the very limits of their capabilities. CF-18 pilots performed formation flying with different types of aircraft, instrument flying, tactical serials of electronic warfare, and at night.⁵⁶

These daily exercises kept pilots up and ready in combat flight techniques. Canadian pilots, even though often specialised in only one combat role, undergo training in all aspects of combat duty; a refresher course like the "red" exercises sufficed to bring back the necessary skills for carrying out different missions. If not, pilots were chosen for particular missions, in accordance with their respective experience.⁵⁷

In summary, CF-18s performed superbly in the Gulf War but was left with important, interoperability issues to contend with in the future. Most notable, the air force had to deal with: 1) deficiencies in tactical air communications (secure voice communications such as Link-4 and Havequick); 2) strategic refuelling limitations and capabilities; 3) lack of a precision-guided munition capability; and 4) training and doctrinal differences with NATO members. From 1991 through 1999, the Canadian air force worked these issues through the wickets of modernization program requirements but the task at hand was difficult due to budgetary constraints. As discussed in the next section, the air force was partially successful in three of the four areas.

The Intermittent Years -- 1992 through 1998

The Persian Gulf War saw Canada's air forces committed to battle for the first time in thirty-eight years, yet it came at a moment when the very need for such forces became a central question in Canadian decision-making. With the demise of the Soviet Empire and a Cold War enemy disappearing, the debate over a need for NATO became an issue in some academic circles. The Canadian government saw no nation posing a threat warranting extensive military preparations. In the mid-1990's, Canadian air and land contingents in Europe within NATO were reduced, then later withdrawn to Canada; now approached the search for a new *raison d'être* for the Canadian military forces.

Canada's military circumstances changed enormously over these years. The financial condition of the country had worsened considerably and the Government had to make hard choices. The defence budget started a constant decline in 1989. In November 1993, the Prime Minister announced a comprehensive review of Canadian defence policy; this marked a turning point for the Canadian air force. In 1994-95, the federal debt was approximately CA\$750 billion with annual debt servicing payments alone amounting to CA\$44 billion, some 27 percent of the total federal budget.⁵⁸ The Government had to resolve this problem and avert a crisis of confidence in the Canadian economy; more significant cuts were on the horizon for the defence establishment. The 1994 Defence White Paper laid out a five-year program to provide Canadians with better value for their defence dollars.

In the past, the Department and the Canadian Forces absorbed reductions in a variety of ways, to include cuts in personnel levels, shrinking of operations and maintenance budgets, reductions in defence infrastructure, and cancellation and/or delays of capital programs. The 1994 Defence White Paper stated that cuts would be deeper with more reductions, cancellations and delays. Some of the most advanced and sophisticated modernization programs of the air force became difficult to justify. The use of CF-18s to track an aircraft engaged in drug smuggling simply was not cost effective. The domestic crises of the Saguenay floods (1996), Red River floods (1997) and Quebec-Ontario ice storm (1998), placed the value of ground troops in the public eye. The 1994 Defence White Paper emphasised that the relative weights of the naval, land and air establishments that had prevailed for many years in the past would be adjusted, primarily to allow for the transfer of resources to land combat and combat support forces. The emphasis was now on army needs; land and air elements each had about CA\$3 billion in budgets and by 1998 the air arm budget had fallen to CA\$2.2 billion.⁵⁹ By 1998-99,

the defence budget had been reduced by 23 percent, to CA\$9.25 billion, down from more than CA\$12 billion in 1994 (representing about 1.2 percent of Canadian GDP).⁶⁰ Planned acquisitions would get cut by at least CA\$15 billion over the next 15 years and a large number of projects eliminated, reduced or delayed.⁶¹

By 1999, the strength of the Regular Forces was reduced to 60,000 and the Primary Reserve to 23,000, a reduction of 32 percent from 1989 levels.⁶² Projections for the operational air force were dark and gloomy. Expenditures on fighter forces and support was reduced by 25 percent.⁶³ To achieve these savings, the air force would have to retire the CF-5 fleet, cut the cost of fighter-related overhead, reduce the annual authorised flying rate, and reduce the number of operational CF-18 *Hornet* fighter aircraft.⁶⁴ Today, measured by the number of personnel, the Canadian air force is at its smallest size since 1948, and its operational fighter squadrons has been reduced to four.⁶⁵ Planners expected these changes to prolong the life of the CF-18 and delay the need to buy a replacement aircraft well into the next century.

Lastly, the 1994 Defence White Paper proposed enhancements to the CF-18 through the acquisition of a limited number of precision-guided munitions. The intent was to provide a close air support capability, reduce interoperability problems with US aircraft and maximise the usefulness of the aircraft. In 1996-97, the Canadian air force purchased 13 target acquisition/designation pods (the Lockheed Martin AAS-38A/B Nite Hawk B forward-looking infrared (FLIR) and a small inventory of 500-pound GBU-12 laser guided munitions and AGM-65G Maverick missiles.⁶⁶ The Nite Hawk FLIR enhanced the CF-18s night attack capability by providing real-time FLIR thermal imagery displayed on one of the cockpit CRTs and HUD.⁶⁷ This enhancement to the CF-18 helped achieve one of the stated objectives of the Government, "for the armed forces to operate with the modern forces maintained by the US and like-minded

nations against a capable opponent--that is, able to fight alongside the best, against the best. Canada must maintain military interoperability and technical interface with US counterparts in a variety of situations.”⁶⁸

Canada-US defence cooperation occurs through a wide range of bilateral arrangements, including formal government-to-government agreements, interdepartmental memoranda, and service-to-service understandings. These arrangements cover joint planning and operations and combined exercises. From 1992 through 1999, the Canadian air force continued to diligently pursue several avenues to resolve the training and doctrinal differences with NATO members. Some examples included participation in Maple Flag, William Tell, Red Flag, Silver Flag, Blue Flag exercises and rated officer exchange programs with the USAF and USN.

Exercise Maple Flag is an annual international air combat exercise held at 4 Wing Cold Lake, Canada with over 290 fighter, bomber, transport, early warning, and command and control aircraft (of which, 72 percent are US aircraft).⁶⁹ The aim of the exercise is for allies to practice warfighting skills in a modern simulated, large-scale combat environment emphasising large package Coalition air forces.⁷⁰ On an annual basis, Maple Flag produces over 4,000 hours of flying in air-to-air, air-to-ground, air-to-air refuelling, tactical resupply, and suppression of enemy air defence.⁷¹

William Tell is the USAF's premier air-to-air weapons competition held at Tyndall AFB, Florida with the motto: "Train to fight, and fight to win." William Tell has become synonymous with the competition for air-to-air supremacy.⁷² This exercise pushes fighter units to achieve air superiority under combat conditions and to intercept and destroy enemy jets. The exercise assesses tactics and weapons and fine-tunes air and ground crews. In short, it tests the best fighters from USAF Major Commands and one Canadian team during mock air battles.

Lastly, the Canadian air force addressed its problem with the lack of strategic refuelling capability in 1996-97. The Canadian Department of National Defence signed an arrangement to aerial refuelling, implementing the Memorandum of Understanding with the United States Department of Defence concerning mutual support. The purpose of the arrangement is to promote interoperability between forces of the US and Canada by providing the framework within which the United States Transportation Command (USTRANSCOM) provides aerial refuelling support to Canadian Forces aircraft.⁷³ The Canadian air force utilized USAF tanker support effectively during the deployment and return of CF-18s in route to the Balkans during Operation ALLIED FORCE.

The final interoperability issue identified during Operation DESERT STORM, that of a lack of secure voice communications, was not resolved during these years. The cost of upgrading the entire CF-18 fleet was simply too prohibitive, with an approximate cost of CA\$816 million.⁷⁴ This issue resurfaced again during the Balkan air campaign of 1999 and the cost to modernize had risen to CA\$1.205 billion.

Operation ECHO (Task Force Aviano) - - CF-18s in the Balkan Air Campaign

After the failure of repeated international diplomatic efforts to peacefully resolve the conflict in Kosovo, the North Atlantic Council decided on 23 March 1999 to authorise NATO air strikes against strategic targets in the Federal Republic of Yugoslavia. In taking these actions against President Slobodan Milosevic, NATO forces demonstrated unrivalled military prowess by executing the largest combat operation in NATO's history. At the outset of Operation ALLIED FORCE, NATO set specific strategic objectives for use of force in Kosovo that later

served as the basis for its stated conditions to President Milosevic for stopping the bombing.

NATO's objectives were to:⁷⁵

- demonstrate the seriousness of NATO's opposition to Belgrade's aggression in the Balkans and its support of peace;
- deter Yugoslavian President Slobodan Milosevic from continuing and escalating his attacks on helpless civilians by imposing a price for those attacks;
- damage Serbia's capacity to wage war against Kosovo in the future or spread the war to neighbours by diminishing or degrading its ability to wage military operations.

Prosecution of Operation ALLIED FORCE was originally planned as a five phase air campaign under NATO's operational plan:⁷⁶

- Phase 0 – the deployment of air assets into the European theatre.
- Phase 1 – establish air superiority over Kosovo and degrade command and control over the Federal Republic of Yugoslavia. (A limited air response relying predominantly on cruise missiles to strike selected targets throughout the Federal Republic of Yugoslavia was developed as a stand-alone option and integrated into Phase 1.)
- Phase 2 – attack military targets in Kosovo and those Federal Republic of Yugoslavia forces south of 44 degrees north latitude, which were providing reinforcement to Serbian forces into Kosovo. (This would allow targeting of forces not only in Kosovo, but also in the Federal Republic of Yugoslavia south of Belgrade.)
- Phase 3 – expand air operations against a wide range of high-value military and security force targets throughout the Federal Republic of Yugoslavia.
- Phase 4 – redeploy forces as required.

NATO campaign planners designed the phased air campaign to increase the military pressure on President Milosevic, targeting not only Serbia's Integrated Air Defence System (IADS) and command and control sites, but also fielded forces and targets of military significance in Kosovo and eventually throughout the Federal Republic of Yugoslavia.⁷⁷ This required air assets with precision guided munition capabilities, of which only a few NATO nations possessed. The Canadian multi-role CF-18 *Hornet* met the requirements and became a vibrant workhorse in the Balkan air campaign.

As the Balkan air campaign continued, Allied aircraft numbers increased, until by the end 829 aircraft from 14 countries were available for tasking, with two thirds coming from the United States.⁷⁸ In total, NATO allies provided 327 manned and unmanned aircraft and flew over 15,000 sorties.⁷⁹ For 78 days, Air Force assets put the pressure on all the resources of President Milosevic. According to General Michael E. Ryan, the USAF Chief of Staff, “the 11-week NATO-driven air strike was considered a major effort that evolved into a major theatre war. By percentage of force – tankers, bombers, fighters, ISR assets, by almost any measure you can think of – Operation ALLIED FORCE, combined with other US contingency deployments around the globe, was bigger than the US effort in Operation DESERT STORM, or that in Vietnam.”⁸⁰ Overall, 38,004 sorties were flown in around-the-clock operations, of which 10,484 were strike sorties; Operation ALLIED FORCE became the most precise and lowest-collateral damage air campaign in history, with a loss of only two aircraft and no US or allied combat casualties.⁸¹ Plus, NATO was successful in keeping to a minimum collateral damage or civilian casualties. Allied aircrews delivered more than 23,000 bombs and other munitions with less than 20 incidents of collateral damage.⁸²

Operation ECHO (called Task Force Aviano) was the first Canadian combat mission in Europe since WWII and the most extensive Canadian air force combat operation since Operation DESERT STORM of 1991. Canada committed eighteen CF-18s, based in Aviano, Italy to the NATO air campaign; the CF-18s flew a total of 678 combat sorties for over 2,500 flying hours.⁸³ Operation ECHO validated the CF-18s interoperability improvements with Coalition forces in the areas of Doctrine, Tactics, Training and Equipment. CF-18s were able to integrate seamlessly with other NATO aircraft and form up each night as part of a multi-national package of dozens of Coalition tactical fighters. According to Lieutenant General Dave Kinsman, “this

was developed over the years by taking part in exercises such as Maple Flag in Cold Lake, Red Flag in Nevada and NATO exercises in Europe. This ability to plug into a Coalition air operation is not a skill developed overnight. Canada's long-standing joint and combined operational experience with the USAF, USN, and the RAF paid dividends in the NATO air campaign."⁸⁴

From 24 March through 10 June 1999, CF-18s flew combat air patrols and air-to-ground (battlefield air interdiction (BAI) and close air support (CAS) combat sorties; below is a brief description of mission type and the interoperability issues and lessons learned from Operation ECHO.

Combat Air Patrols. During the Balkan air campaign, CF-18s demonstrated the flexibility of the multi-role fighter and its aircrews. More than 700 surface-to-air missiles were shot at Allied aircraft (266 from SA-6's, 174 from SA-3's, 106 from man-portable systems and 126 from identified systems).⁸⁵ The average aircrew participating in Operation ALLIED FORCE experienced a missile launch rate three times that encountered by the average coalition aircrew during Operation DESERT STORM.⁸⁶ Their ability to avoid those missiles attest not only to their superb skill but to the technology and the professionalism of a force that knows how to deal with this sort of a threat."⁸⁷ While most of the CF-18 combat sorties were focused on the precision guided munitions, air-to-ground bombing role, CF-18 crews flew 120 sorties (of the 678 sorties) in the air-to-air combat air patrol role armed with two AIM-9M Sidewinder infra-red missiles and four AIM-7 Sparrow Radar guided missiles.⁸⁸ Even during air-to-ground missions, all CF-18s were armed with Sidewinder and Sparrow missiles and there were a few incidents when returning from an air-to-ground bombing mission the CF-18s were tasked as an air-to-air

fighter to investigate “pop-up” enemy air activity.⁸⁹ CF-18 aircrews were fully capable in both air-to-air and air-to-ground roles.

Air-to-ground sorties (BAI/CAS). In Kosovo, the air campaign was conducted under conditions in which there was at least 50 percent cloud cover more than 70 percent of the time.⁹⁰ Despite the adverse weather conditions, rugged mountainous terrain, and the high threat environment, allied aircrews fought an air campaign with precision. Of the 9,400 designated target impact points, more than 70 percent were struck with precision munitions.⁹¹ Because few NATO countries could employ precision munitions in sufficient numbers (or at all), the US conducted the preponderance of the strike sorties. But, the CF-18s were an integral part of the combat operational strikes largely due to the 1996/97 acquisition of precision guided munitions and laser designator pods. Operation ALLIED FORCE was Canada’s first combat employment of precision guided munitions. The CF-18s were extremely effective; the theatre air Commander for Operation ALLIED FORCE considered the CF-18s to be “on the first team” because of its valuable day/night capability to deliver laser guided bombs.⁹² Over the 11-week air campaign, CF-18s delivered over 530 bombs, including 241 laser guided 500-pound GBU-12 and 120 2,000-pound GBU-10 munitions and 171 Mk-82 500-pound general purpose “dumb” bombs, on a variety of military targets throughout Kosovo and the Federal Republic of Yugoslavia.⁹³ (Canada purchased the 2,000-pound GBU-10 from the US during the air campaign under a Foreign Military Sales buy to attack hardened targets such as bridges, tunnels and airfields.)⁹⁴

The ability of the CF-18 to contribute quickly to the bombing campaign was enhanced from the deployment of CF-18s to Aviano, Italy for a one-time, three-month deployment in 1997. The experience gained on this deployment allowed CF-18 aircrews to quickly react and

adapt to the Balkan environment. During the air campaign, a Canadian fighter pilot was selected as the Package Commander of an entire formation or Package Coordinator for 50 percent of the large fighter packages that CF-18s flew in; this was not a distinction shared by many of the other NATO air forces.⁹⁵ The Package Commander was responsible for planning, briefing and execution of a NATO strike package of up to 50 aircraft while a Package Coordinator had responsibility for a NATO strike package of up to 20 aircraft. This was a considerable undertaking especially in light of the smaller percentage of aircraft and aircrews committed to the air campaign.

On most attacks into Kosovo and the Federal Republic of Yugoslavia, CF-18s were dedicated bomb droppers. A typical strike package included four CF-18s of sixteen dedicated tactical aircraft consisting of electronic warfare, suppression of enemy air defences and fighter escort aircraft. In addition, ABCCC, AWACS and air-to-air refuelling tankers supported the strike packages ingressing and egressing enemy air space; the air space was highly congested.⁹⁶

Problems. Combat experiences in Operation ALLIED FORCE again revealed capability requirements for new and upgraded equipment such as night vision goggles, sensors and communications and mission computers improvements.⁹⁷ Many of these requirements were previously identified by the Canadian air force after the Persian Gulf War and was addressed in the CF-18 Incremental Modernization Program.

1) No night vision goggles (NVG) or helmet-mounted cueing sight. Many aircraft in theatre had NVG's and cockpit devices; the CF-18s did not and ultimately flew combat sorties with a higher risk. Also, the CF-18 does not have helmet-mounted sight capability, a deficiency that restricts high off-boresight weapons designation and launch capability.⁹⁸ But this was the case for several aircraft within theatre, to include the USN EA-6B *Prowler*, USMC F/A-18

Hornet and AV-8B *Harrier* and some USAF F-16 *Falcons*.⁹⁹ On a typical night, a strike package of 15 to 20 aircraft had to avoid incoming SA-2 and SA-3 missiles coming off the ground. The situation got complex rather fast, with aircraft pulling seven or eight G's to avoid the missiles. Aircraft not having NVG's were given cleared altitudes and air spaces to avoid air-to-air collisions with friendly aircraft. The United States Congress provided Supplemental Defense Funding Authorization after Operation DESERT STORM to rectify the problem with the USN and USMC, and that included cockpit configurations as well as NVG devices and training for pilots.¹⁰⁰ The Canadian air force addressed this problem under the Omnibus CF-18 Incremental Modernization Project.

2) No Strategic Air-to-Air refuelling capability. The Canadian air force does not have a strategic air-to-air refuelling capability; *Husky One*, a Boeing 707 Strategic tanker, was retired from active service after Operation DESERT STORM. As discussed earlier, Canada and the US signed a Memorandum of Understanding to meet Canadian strategic air-to-air refuelling requirements. For Operation ALLIED FORCE, the CF-18s utilised USAF tanker assets to deploy initial aircraft to Aviano, Italy. Once in theatre, the bulk of the Coalition tanker support was provided by USAF KC-135 and KC-10 tankers. Aerial refuelling became one of the most challenging aspects of Operation ALLIED FORCE. Active and reserve component tankers provided multiple air bridges for aircraft transiting to the theatre, while also supporting combat air sorties, a staggering 80 percent of the tanker crews were called into action.¹⁰¹ In addition, extensive tanker support was required for B-2 bombers flying sorties from the continental United States. Due to these high demands on USAF air-to-air refuelling assets, the Canadian air force had to use its own KC-130 *Hercules* tactical air-to-air refuelling tankers on several occasions in conjunction with "island hopping" routes to transit aircraft to and from Canada to Aviano, Italy.

3) Limitations with numbers of FLIR pods for PGM's. Precision guided air-to-ground strike sorties were limited due to the number of Nite Hawk FLIR pods, only 13 pods were purchased in 1996. In Operation ALLIED FORCE, 12 CF-18s were configured with the FLIR pods to conduct air-to-ground combat sorties while the remaining six aircraft were configured for air-to-air combat air patrol operations.¹⁰² National Defence Headquarters is currently reviewing the role for PGM's as a result of the experiences gained in the air campaign; CF-18s experienced an overall 65-70 percent success rate with laser guided bombs, about in line with NATO allies.¹⁰³ In addition to the pods, the Canadian air force depleted stock levels of the GBU-12's and obtained only a limited number GBU-10's from US sources for the air campaign. Stockpiles must be replenished to meet future mission requirements. Secondly, the CF-18 does not have the Stores Management System ability nor necessary weapons interfaces required by many current generation weapons such as advanced air-to-air weapons and many types of PGMs.¹⁰⁴ This issue is addressed by the CF-18 Incremental Modernization Project and other related CF-18 capital projects.

4) Lack of secure voice communications, data link interfaces and identification friend-or-foe equipment. The lack of interoperable secure communications forced reliance on non-secure methods that compromised operational security in Operation ALLIED FORCE. Use of Havequick and Link-16 or wide band data reception is absolutely essential for Coalition-type combat operations. The lack of a wide band data capability in Operation ALLIED FORCE restricted some Coalition aircraft from having a fully integrated air picture, thus making it more difficult to operate in a high tech environment. In general, a Link-16 data link interface helps reduce the fog of war experienced in a densely compacted environment in the air. In Operation ALLIED FORCE, NATO forces had to transit regions in which everyday air activities, including

commercial air traffic, continued unabated, further complicating command and control of air assets. In the United States, the Department of Defense is pursuing Link-16 capability for US aircraft as the main step in the sensor-to-shooter program. The United States Congress provided supplemental funding in FY'00 for Link-16 upgrades.¹⁰⁵ The Canadian Omnibus CF-18 Incremental Modernization Project addresses this concern for the CF-18.

In summary, Operation ALLIED FORCE demonstrated that a significant disparity continues to exist between USAF capability and NATO capability in terms of technology. The gaps in capability were real and in some areas impeded the Coalitions' ability to operate at optimal effectiveness. As discussed in the next section, several things can be done by NATO allies to enhance interoperability that do not require great leaps in technology, to include: secured communications and identification friend-or-foe equipment; Link 16 data link interfaces and night vision goggles. Canada is at the forefront. According to Lieutenant General Dave Kinsman, "Canada must continue to ensure that we can interact effectively in this environment."¹⁰⁶

OMINBUS CF-18 INCREMENTAL MODERNIZATION PROGRAM (CF-18 IMP)

Since 1987, Canada's National Defence Headquarters has diligently worked on steps to extend the Engineering Life Expectancy (ELE) of the CF-18A/B *Hornet* with upgrades through various modernization programs, to include the "Mid-Life Update" program, "Systems Life Extension" program, and a "Fatigue Life Management" program after Operation DESERT STORM. The slightly modified CF-18A/B *Hornet* is based on 1970s technology and has an ELE of 2010, something had to be done to modernize the fleet to ensure a survivable and viable fighter weapons platform capable of performing the government assigned roles and missions

detailed in The Defence Strategy 2020, Defence Planning Guidance 2000 and Chief of Air Staff Planning Guidance 2000. The most recent modernization project is the Omnibus CF-18 Incremental Modernization Project which extends the useful operational life of the CF-18A/B *Hornet* to the 2017-2020 timeframe; CF-18 IMP addresses the minimum operational requirements for enhanced interoperability, survivability, supportability and capability.

The CF-18 IMP is the central element of CF-18 modernization and encompasses seven other related projects: Advanced Air-to-Air Weapons Project—Short Range; Advanced Air-to-Air Weapons Project—Medium Range; Advanced Air-to-Surface Weapons Project; Radar Warning Receiver Modernization Project; Embedded Global Positioning/Inertial Navigation Project; Air Combat Manoeuvring Instrumentation; and Stand-off/All Weather Air-to-Surface Weapons.¹⁰⁷ The CF-18 Statement of Operational Requirement requires the integration of all projects within the CF-18 IMP be interoperable with one another and be supportable to the Estimated Life Extension of 2017-2020.

Canada's overall defence priorities and the current budgetary situation do not allow for an immediate, comprehensive upgrade of the CF-18. Under an existing CF-18 IMP, upgrades are planned incrementally under a 2-phased program. These incremental upgrades to the aircraft's most critical systems ensure the CF-18 operates effectively in a Coalition environment, with the intent of upgrading the fleet to existing McDonnell Douglas F/A-18C/D configuration standards. The proposed, newly configured aircraft would give Canada a precision strike fighter that meets and beats the threat through the first part of the 21st century. With the proposed enhancements, the CF-18 will be able to carry almost every tactical air-to-air and air-to-ground weapon in the US inventory (additional munitions capabilities include: AMRAAM, Harpoon, HARM, Shrike, SLAM, SLAM-ER, JSOW, and JDAM) and fully capable to conduct combat

missions alongside US assets. This includes air superiority, day/night strike with precision-guided weapons, fighter escort, close air support and suppression of enemy air defence.

Prior to Operation ECHO (Task Force Aviano), Air Command staffed the CF-18 IMP as a 3-phased program with 13 projects to ensure the continued operational effectiveness of up to 100 CF-18s -- at a total cost of CA\$1.180 billion.¹⁰⁸ The projects included¹⁰⁹:

	PROJECT	COSTS
IMP #1	Mission Computer (XN 10)	CA\$36 million
IMP #2	Advanced USN Operational Flight Program	CA\$34 million
IMP #3	Radios (Jam Resistant, Saturn, SATCOM)	CA\$47 million
IMP #4	APG 73 Radar	CA\$494 million
IMP #5	Combined Identification Friend-or-Foe (IFF) Interrogator	CA\$39 million
IMP #6	New Displays	CA\$120 million
IMP #7	Link 16	CA\$65 million
IMP #8	ALQ 126B Modernization	CA\$4 million
IMP #9	ALQ 162 Modernization	CA\$37 million
IMP #10	Missile Approach Warning System (MAWS) / IR Jammer / ALE Modernization	CA\$49 million
IMP #11	Stores Management System Upgrades	CA\$170 million
IMP #12	Helmet Mounted Sight / Cueing System	CA\$50 million
IMP #13	Simulation Modernization (ADCTS)	CA\$35 million

The implementation program had a final completion date of 2008 and was based on three priorities: 1) assist supportability; 2) capability increase as soon as possible; and 3) minimise the total program costs.¹¹⁰

- Phase 1 (Initial Operational Capability of 2002) – Mission Computer, Operational Flight Program, Havequick II, GPS/EGI, IFF Interrogator and some APG 73 (\$ dependant).
- Phase 2 (Initial Operational Capability of 2005) – APG 73, Displays, Link 16, SMS Upgrades.
- Phase 3 (Initial Operational Capability of 2008) – Radar Warning Receiver, Pulse and Continuous Wave Jammers, Chaff/Flare, MAWS/IR Jammer, Helmet Mounted Sight /Cueing System with follow-on of advanced stand-off weapons, advanced air-to-air weapons, and stealth.

Priorities changed after a thorough review of the lessons learned from Task Force Aviano and the Balkan air campaign. Lessons learned from active participation of CF-18s in Operation ALLIED FORCE reprioritised the phase upgrades and shortened the timelines. As noted earlier, Task Force Aviano reinforced previously stated operational requirements from Operation FRICTION in the Persian Gulf War. Resurfaced were some of the same issues: lack of jam resistant and secure radio equipment; enhancements with PGM and Nite Hawk operations; identification of friend-or-foe capability; radar/missile range capability and limited autonomous operations capability. Operation ECHO demonstrated requirements for numerous key upgrades as soon as possible, to include: jam resistant/secure radios; APG 73 for longer range, autonomous operations; combined interrogator transponder for autonomous operations; GPS integration for accurate Nite Hawk employment; and Stores Management System for digital weapons capability like AMRAAM. Task Force Aviano indicated that greater capability was needed sooner than previously planned, and this changed the modernization program strategy. The 13 projects of the original CF-18 IMP were repackaged as 10 individual and independent projects (nine on aircraft and one off aircraft) and incorporated into a 2-phased implementation strategy with a cost of CA\$1.226 billion.¹¹¹

	PROJECT	COSTS	FUNDING STATUS
IMP #1	Mission Computer (XN 10)	CA\$36M	Purchased/Nov 1998
IMP #2	Advanced USN Operational Flight Program	CA\$34M	Purchased/Nov 1998
IMP #3	Engineering Change Proposal 583 (Cdn) - Secure Radios (Jam Resistant, Saturn, SATCOM); APG 73 Radar; Combined IFF Interrogator Transponder; Enhanced Jam Resistant Digital Communications; Stores Management System Upgrades	CA\$816M	Pending
IMP #4	Multi-purpose Display Group Modernization	CA\$100M	
IMP #5	Simulation Modernization	CA\$35M	
IMP #6	Link 16	CA\$65M	
IMP #7	Pulse Jammer (ALQ 126B Modernization)	CA\$4M	
IMP #8	Continuous Wave Jammer (ALQ 162 Modernization)	CA\$37M	
IMP #9	Missile Approach Warning System (MAWS) / IR Jammer / ALE Modernization	CA\$49M	

IMP #10	Helmet Mounted Sight/Cueing System	CA\$50M	
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The individual components of the Omnibus Project will be incrementally funded and procured under a newly designed 2-phased implementation program with a final completion date for 80 aircraft by 2006.¹¹² In addition, the CF-18 IMP is fully compatible with the previously mentioned CF-18 missiles/munitions capital projects.

- Phase 1 (Initial Operational Capability of 2003/Final Operational Capability of 2006)
– Mission Computer (XN 10), Advanced USN Operational Flight Program; ECP 583 (Cdn), GPS/EGI, Multi-purpose Display Group Modernization with follow-on ADCTS, Advanced MRAAM, Advanced SRAAM.
- Phase 2 (Initial Operational Capability of 2006/Final Operational Capability of 2008)
– Data Link 16, Pulse/Continuous Wave Jammers, Chaff/Flare, Missile Approach Warning System/IR Jammer, Helmet Mounted Sight/Cueing System with follow-on advanced stand-off weapons and stealth.

On 26 November 1998, Departmental Effective Project Approval was received for the first two CF-18 IMP projects (IMP#1, Mission Computers (XN10) and IMP#2, Advanced USN Operational Flight Program). A Statement of Operational Requirement, Omnibus CF-18 Incremental Modernization Project was drafted by the Directorate of Aerospace Requirements on 1 March 2000 and is being staffed through the National Defence Headquarters. On 3 March 2000, National Defence Headquarters held a Senior Review Board for Omnibus CF-18 IMP. This Board was chaired by the Chief of the Air Force (CAS), LGen David Kinsman and the Assistant Deputy Minister (Materiel), Mr. Alan Williams. The Board approved the revised Synopsis Sheet (Identification) SS(ID), approved the continued planning of the IMP with the inclusion of ECP 583, approved the annual expenditure of up to CA\$500 thousand for options analysis work, approved the IMP Project Charter, noted the IMP Statement of Requirements (SOR), and noted the project was included in the 99/00 Level 1 Capital Plan. The CF-18 IMP has the following timeline for IMP#3 (ECP 583):

- 17 May 2000 – Interdepartmental Working Group
 - ❖ Discussed Procurement Strategy of ECP 583
- 30 May 2000 – Senior Review Board
- 5 June 2000 – Senior Management Oversight Committee
 - ❖ Reviewed/endorsed the Statement of Operational Requirements
- 8 June 2000 – Joint Capabilities Review Board
 - ❖ Endorsed Effective Project Approval (EPA) of ECP 583
 - ❖ Reviewed/endorsed Procurement Strategy
- 29 June 2000 – Program Management Board
 - ❖ Grant Departmental EPA of ECP 583
- 21 July 2000 – Treasury Board Submission
 - ❖ Forward to the Minister of National Defence
- August/September 2000 – Treasury Board
 - ❖ Receive Treasury Board expenditure authority

The National Defence Headquarters has identified the requirements for meeting its commitments to NATO and NORAD. Funding approval for ECP 583 appears optimistic; in April 2000 the Treasury Board stated the purchase of ECP 583 would not be classified as a Major Crown Project and that DND does not have to take the proposal to the Cabinet for approval. This was reaffirmed on 16 May 2000 by the Privy Council which confirmed the position that ECP 583 would require no special ministerial scrutiny / approval and should proceed directly to Treasury Board once DND departmental approval is received in June 2000. As the CF-18 IMP moves through the review/approval process, the remaining IMP's must compete with other major air force modernization programs, including DND's number one procurement priority of *Sea King* replacement by 2005 (Major Crown Project of Maritime Patrol Helicopter) and CP-140 *Aurora* modernization. With limited funding availability, the road is clearly a tough one.

In a 1998 report on DND, the Auditor General of Canada told Parliament that "the military would have only half of the CA\$7 billion necessary for weapons purchases and upgrades

over the next five years just to maintain current capabilities. The Department cannot afford all the equipment forecast to fully modernize the Forces."¹¹³ According to David L. Rudd, Executive Director of the Canadian Institute of Strategic Studies, "there's a definite mismatch between Canada's desire to remain a player on the world stage and the ability of the armed forces to carry it out."¹¹⁴ Canadian defence spending as a share of economic output, is now lower than any NATO country except Luxembourg. Military analysts predict that these budget realities will soon force Canada to abandon any hope of fighting alongside the US and other NATO allies in combat that requires modern and expensive new weapons systems. Given these realities, Dr. Joseph Jockel, a professor of Canadian Studies at St. Lawrence University said "Canada should probably focus its limited defence budget on beefing up its peacekeeping, a role more in line with the image Canadians have of themselves as kindler and gentler than their more warlike American neighbours. Like it or not, this is a military that is being equipped largely for peacekeeping."¹¹⁵ Without reinvestments in CF-18 modernization, key air force capabilities will degrade to the point where CF-18s will no longer be employable.¹¹⁶

CONCLUSION

Canadian and United States shared security is guaranteed by a series of declarations and agreements: the Kingston Declaration of 1938, the Ogdensburg Agreement of 1940 between Prime Minister McKenzie King and President Franklin D. Roosevelt, the North Atlantic Treaty of 1949, and the North American Air Defence Agreement of 1957.¹¹⁷ Canada and the US maintains the longest lasting bi-lateral defence arrangement of the 20th century through the Permanent Joint Board on Defence (PJBD) and its derivative body the Military Cooperation Committee (MCC). The PJBD was established in 1940 by President Roosevelt and Prime

Minister Mackenzie King. Its mission was set out in the Ogdensburg Declaration signed by the President and Prime Minister: "to consider in the broad sense the defence of the north half of the Western Hemisphere."¹¹⁸ In practice, senior Canadian and American military and civilian personnel involved in bilateral defence have met and consulted on a regular basis for nearly sixty years on matters related to shared security.

NORAD, established in 1958, formalized existing air defence agreements between the US and Canada and created a binational command structure for air defence of North America. Canadian and American military personnel work side-by-side at facilities in both countries, sharing authority and responsibility for joint defence. One of the greatest benefits derived from NORAD is the ability to share resources and costs needed for aerospace security. It would be militarily and economically impractical for either nation alone to monitor and protect the airspace.

As partners in North American defence and peacekeeping elsewhere in the world, the US and Canada both need high quality, well-equipped, professional defence forces, capable of undertaking all appropriate defence tasks jointly and in coalition with our allies.

Operation ALLIED FORCE highlighted a number of disparities between US capabilities and those of the Canadian air force (and other NATO allies), including precision strike capability, strategic refuelling, command-and-control and information systems, and secure communications. These disparities seriously effect the ability to operate as an effective alliance over the long term.

Without comparable capabilities, Coalition military operations degenerate to the lowest common denominator. C4ISR, Information Technology and Network Centric Warfare only works if everyone in the Coalition side has them.¹¹⁹ Bringing the CF-18A/B *Hornet* up to a level

of “interoperability” with US capabilities is as much a problem of “releasability” as “affordability.” Prospects in Canada for any significant increase in defence spending appears slim. The 2000 Federal Budget allocates DND CA\$400 million in new funding in fiscal year 2000-01, CA\$550 million in fiscal year 2001-02 and an additional CA\$600 million in fiscal year 2002-03.¹²⁰ According to the Minister of National Defence Minister, The Honourable Art Eggleton, “the reality is that the Defence Department will probably have to do better with the resources we have.”¹²¹ At present, personnel costs account for 45 percent of the defence budget, operations and maintenance account for 31 percent, transfer payments account for 5 percent, and capital investment accounts for 19 percent.¹²² According to the Auditor General, “without increased capital investment the Canadian Forces faces eventual “rust out.” The Defence Department plans to increase the capital portion of the defence budget to a minimum of 23 percent over the next five years.¹²³

If Canada is to meet future military challenges effectively, National Defence Headquarters must successfully implement the Defence Capabilities Initiative adopted at the 1999 NATO Summit in Washington D.C. Canadian implementation of the 10 projects in the Omnibus CF-18 Incremental Modernization Project will enhance interoperability between the US and Canadian air forces. The core of Canadian modernization is The Defence Strategy 2020—Canadian Defence into the 21st Century. This document envisions the force structure of the Canadian Forces providing Canada with modern, task-tailored and globally deployable combat-capable air forces that can respond quickly in joint or combined operations. The Strategic Direction and Vision are clearly outlined: “to strengthen Canada’s military relationship with the US military to ensure Canadian and US forces are interoperable and capable of combined operations.”¹²⁴ Defence Strategy 2020 builds on the existing defence policy to

articulate the long-term strategic objectives and shorter-term, 5-year targets. Two objectives are key to the CF-18 IMP:

- Objective 3: Modernize. Conduct a focused, paced and innovative modernization program with a minimum of 23 percent of the Defence Services Program in capital.
- Objective 5: Interoperable. Strengthen Canada's military to military relationships with principal allies ensuring interoperable forces, doctrine and C4I.

Air power will continue to shape the battlespace to allow naval and land forces to exploit the impact of air operations. As in Operation DESERT STORM, the conditions for victory were set in Operation ALLIED FORCE because the Coalition owned the sky: the Coalition had air superiority. Across the spectrum of conflict, air supremacy is now the *sine qua non* of US military activity, the arm of choice and the enabler and protector of all other arms.¹²⁵ Air supremacy is not an inalienable, God-given right; it can be lost. Technological superiority is neither automatic nor guaranteed. President Theodore Roosevelt once said that we should "walk safely but carry a big stick." Diplomacy, to be effective, must be backed up with a credible ability to deter aggression, to enforce agreements and to ensure that the will of the international community is carried out.

Recently, Canadian policymakers were at a significant crossroad and difficult choices had to be made to either modernize the CF-18A/B *Hornet*, consider early retirement for its tactical fighter fleet to avoid a massive block replacement of aircraft between 2017 and 2020 and replace the existing fleet in the near term, alter Canadian air force mission requirements and obligations within NATO and NORAD to allow further extension of the current airframe or reduce the number of aircraft to be modernized and the scope of the modernization program. Conceivably, the Canadian government could have even grounded all the CF-18s and reach new arrangements with the United States to undertake sovereignty protection and control of Canadian airspace and territory. Policymakers must regularly confront tough choices. Investment in national security

does not always pay immediate dividends, and may not have the same degree of vocal support as more domestic expenditures.¹²⁶ History shows that it pays off over the long run. Approval and full funding of ECP 583 in July 2000 provides for 72 percent of the total cost of the CF-18 IMP, with the remaining seven IMP's needing CA\$340 million to complete the CF-18 modernization effort. Funding approval will most likely occur for the remaining IMP's due to DND's procurement strategy.

Air Chief Marshal Sir Richard Johns, the RAF Chief of the Air Staff, sums it best when he highlights three conditions on the future role and status of air power:¹²⁷

- The primary role of any air force is to win and sustain control of the air;
- Control is and will remain essential to the success of military operations in the joint environment of today and tomorrow;
- Air power, with its inherent characteristics of height, speed and reach enhanced by technological advances in weapons precision and target acquisition, have made it the capability of first choice in the containment of crises or, in the event of conflict, as the primary tool for shaping the battlespace to permit the effective and battle winning employment of surface forces.

The USAF and the Canadian air force, working side by side with partners in industry and the private sector, help to ensure both nations are secure from all threats. Working together as an "interoperable" team is definitely much greater than the sum of our individual parts. Failure to fund the Omnibus CF-18 IMP weakens Canada's overall fighting strength and increases the risks to aircrews performing their missions.

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